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CONTENTS

Page

Abstract 1

Introduction 1

Methods and materials 1

Results and discussion 2

Conclusions 3

Literature cited 3

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Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE
In Cooperation With
Arizona Agricultural Experiment Station

COTTON: COMPARISON OF TEMPERATURES IN NARROW- AND NORMAL-SPACED ROWS

R. E. Fye [1]

ABSTRACT

Cooler temperatures generally occurred within the canopy of cotton placed with two rows on a flattened bed as compared with temperatures in cotton planted in 40-inch rows on an unflattened bed. An increased modification of 2° to 3° F occurred in the narrow-spaced cotton until both cottons reached full canopy growth. Therefore, the narrow spacing resulted in earlier moderation of the high, suppressive temperatures of early season. This suggests that insect problems may occur somewhat earlier in the narrow-spaced cotton as compared with the normal-spaced cotton.

INTRODUCTION

In some areas, temperature is a critical factor in insect development and mortality. The modification of ambient temperatures by the environment must be considered quantitatively during the interpretation of insect population dynamics. The effects of temperature on development and the reproductive potential of several species of Lepidoptera have been investigated by Fye and Poole (6) [2] and Fye and McAda (5). The temperatures within cotton canopies and of the various plant parts of cotton have been discussed by Fye and Bonham (3) and Fye (1, 2), and the development of the cotton canopy has been described by Fye and Carranza (4). The following study was made to determine the temperature differentials in the various plant parts of cotton in narrow-spaced cotton (two rows on wide, flattened beds) as compared with temperatures in normal-spaced cotton (single rows on unflattened beds). In the study, 60,000 plants per acre were grown on the narrow-spaced rows; 30,000 plants per acre, on the normal-spaced cotton.

METHODS AND MATERIALS

Copper-constantan thermocouples were installed at various points within the canopy in rows of normal- and narrow-spaced cotton. The thermocouples were spread over the plants and placed in the soil surface in representative locations to determine the temperatures throughout the cotton environment. Air temperatures were recorded under a simple shade consisting of an 8- by 8-inch foil-covered square of plywood placed over bare soil on a 4-foot stake. In 1971, temperatures were recorded at 0.5-hour intervals for 24-hour periods on July 2 and 3, 8 and 9, 14 and 15, 28 and 29, and during the daytime on August 3 at Marana, Ariz. The data were divided into daytime and nighttime readings on the basis of the sunrise and sunset in the area.

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[2] Underscored numbers in parentheses refer to Literature Cited, p. 3.

RESULTS AND DISCUSSION

The mean temperatures and the associated standard deviations are presented in table 1. For July 2 and 3, 1971, when the cotton was about 12 to 13 inches in height, the temperatures associated with the cotton plants were very similar. The terminals and the air temperature within the canopy were slightly higher than the temperature between the square bracts and the square itself. The data, particularly when the broad standard deviations are considered, indicate little difference in the cotton plant canopy at this early date. The daytime temperatures on the soil surface beneath the narrow-spaced cotton are appreciably lower than the temperatures of the soil surface beneath the normal-spaced cotton and indicate extra shading by the increased plant density. The temperatures associated with the more open parts of the soil surface resulted from direct exposure to sunrays during the day. The higher temperature 4 inches from the row resulted from the small canopy coverage noted above. The high temperatures on the side of the bed were due to direct exposure to the sunrays when the rays struck on the east or west side of the rows. The high temperatures in the row bottom were the result of the sunrays striking the open soil at midday when they were oriented with the row direction. At night, the differences at the soil surface disappeared, but the soil remained somewhat warmer than the nighttime air temperature.

The data for July 8 and 9 (table 1) indicated the temperatures in the narrow-spaced cotton were again somewhat lower than in the normal-spaced cotton during the daytime hours, and a similar differential existed during the nighttime hours. During the week that elapsed after the first temperature readings, the normal-spaced cotton grew at a rapid rate and attained a mean height of 17 inches compared with a mean height of 14 inches for the narrow-spaced cotton. The increased growth and foliage of the cotton planted in normal-spaced rows reduced the temperature differential within the canopy as compared with the earlier readings. The soil temperatures in the narrow-spaced cotton were somewhat lower than those in the normal-spaced cotton both during the day and night. The increased shading of the narrow-spaced cotton probably accounts for this difference. The comparatively lower temperatures attained at the soil surface resulted from an irrigation 3 or 4 days before the dates of the readings.

On July 14 and 15, the cotton planted in the normal-spaced rows had a mean height of 20 inches, and the cotton planted in the narrow-spaced rows had a mean height of 17 inches (table 1). Daytime canopy temperatures in both planting patterns were approximated for the air temperature; however, the temperatures in the bracts of the squares and bolls showed a modification of 2° to 3° F. Modification during the nighttime hours was similar, 2° to 3°. The lower soil surface temperatures during the day resulted from the shading by the plants. Mean temperatures were high only on the bed shoulder where the area recorded was shaded only part of the day. The soil temperatures were generally higher than those recorded on July 8 and 9 because the soil surface had dried considerably although some moist areas were visible. The slightly higher nighttime soil temperatures resulted from heat retention by the soil, which rarely achieves equilibrium with the air temperature.

On July 28 and 29, the cotton planted in narrow-spaced rows averaged only 18 inches in height, whereas the cotton planted in the normal-spaced rows averaged 23 inches. Daytime data (table 1) showed little modification of the temperatures within the plant and on the soil surface. This may be attributed to the partial cloudiness that occurred during the recording period, which resulted in a smaller differential due to the shading by the canopy. The one exception is the higher temperature in the bottom of the row where the area in which the temperature was being recorded was only partially shaded. Nighttime temperatures showed the commonly occurring 2° to 3° F modification within the plant canopy with little or no modification at the soil surface.

The August 3 data (table 1) again demonstrate a 2° to 3° F modification of the air temperature, but the sky was clear, and the modification may be attributed to the effects of the closed canopy. The greater modification is also evident when the high terminal temperatures are compared with the temperatures in the lower sites on the plant. On August 3, there was little or no difference between the modification by the cotton planted in narrow-spaced rows as compared with that planted in the normal-spaced row although the height of the cotton in normal-spaced rows was about 24 inches as compared with 19 inches in the narrow-spaced row cotton.

CONCLUSIONS

The data presented in this study indicate that early in the season the increased plant density of the narrow-spaced cotton created improved shade, which modified the temperatures within the plant canopy and at the soil surface to a greater extent than the cotton planted in normal-spaced rows. Since this is the critical period of the year for bioclimatic suppression of insect populations by high temperatures (5, 6), narrow-spaced cotton may modify temperatures within the canopy and at the soil surface sufficiently to improve insect development and survival. However, after mid-July, the modification of the environment by the cotton canopy will similarly affect both the narrow-spaced and normal-spaced cotton. Therefore, early modification may be critically important in evaluating and assessing insect damage to narrow-spaced cotton.

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TABLE 1.--Temperatures in cotton plants in narrow- and normal-spaced rows in Marana, Ariz.

Site	Daytime				Nighttime			
	Narrow row		Normal row		Narrow row		Normal row	
	No. observations	Temperature ± S.D. (°F)	No. observations	Temperature ± S.D. (°F)	No. observations	Temperature ± S.D. (°F)	No. observations	Temperature ± S.D. (°F)
July 2-3, 1971								
Air	25	93.9± 9.3			23	82.1±6.6		
Plant:								
Terminal	25	94.2± 8.5	25	95.0± 8.6	23	79.2±7.5	23	80.3±7.2
Canopy	150	95.6± 9.8	125	95.6± 9.0	138	78.7±7.2	115	80.4±7.2
Square bracts	150	91.7± 7.8	175	93.8± 7.8	138	78.1±6.7	161	80.3±6.7
Soil surface:								
In row	25	97.0±10.0	25	100.8± 9.8	23	89.7±7.7	23	89.5±7.0
4 inches from row	50	101.1±14.4	50	102.4± 9.8	46	86.6±6.9	46	86.3±7.1
Bed shoulder		(1/)	50	112.3±19.4		(1/)	46	89.0±8.9
Midside of bed	75	104.6±15.9		(1/)	69	88.0±7.2		(1/)
Row bottom	25	104.4±18.5	25	108.6±16.1	23	87.0±7.4	23	87.1±6.1
Midbed	50	99.1±12.9	-	- -	46	88.5±7.2	-	- -
July 8-9, 1971								
Air	27	95.9± 7.4			21	83.6±7.0		
Plant :								
Terminal	27	95.0± 7.6	27	95.6± 6.4	21	77.0±7.0	21	79.0±6.1
Canopy	135	93.2± 7.5	108	95.4± 7.4	105	77.0±7.2	84	79.1±6.9
Square bracts	189	90.7± 6.2	189	92.5± 5.5	147	76.6±7.2	147	79.5±6.0
Boll bracts	27	92.1± 6.9	108	91.9± 6.0	21	77.1±7.1	84	78.4±6.5
Soil surface :								
In row	54	87.3± 6.1	27	95.6± 6.4	42	80.2±3.7	21	90.1±4.6
4 inches from row		(1/)	27	96.5±11.3		(1/)	21	88.3±4.8
Bed shoulder	54	88.3±10.2	27	93.9± 5.3	42	77.7±3.9	21	80.2±6.6
Row bottom	27	86.1± 9.2		(1/)	21	75.7±2.7		(1/)
Midbed	27	92.8± 7.9	-	- -	21	82.7±4.2	-	- -

July 14-15, 1971								
Air	27	91.0±9.3			21	80.6±3.2		
Plant:								
Terminal		(1/)		(1/)		(1/)		(1/)
Canopy	189	91.2±10.7	81	91.7±9.9	147	77.7±3.4	63	79.4±3.4
Square bracts	135	88.3±8.7	81	88.7±8.5	105	77.4±3.3	63	78.8±3.4
Boll bracts	135	88.9±9.9	135	88.2±7.9	105	77.4±3.6	105	79.0±3.4
Soil surface:								
In row		(1/)	27	93.6±10.4		(1/)	21	81.9±3.1
4 inches from row	54	95.2±10.8	27	96.6±10.2	21	85.3±3.3	21	88.4±3.6
Bed shoulder	54	97.1±13.7	27	101.4±15.8	42	83.2±3.8	21	85.5±3.8
Row bottom	27	97.1±14.2		(1/)	21	83.3±3.6		(1/)
Midbed	27	95.0±10.3			21	86.0±3.4		
July 28-29, 1971								
Air	17	92.4±2.8			20	83.2±7.1		
Plant:								
Terminal	34	91.8±2.2	17	92.4±2.4	40	81.1±5.1	20	80.4±6.0
Canopy	85	93.5±2.6	68	92.3±2.7	100	81.7±5.2	80	80.6±5.6
Square bracts	17	91.5±3.4	51	89.6±2.1	20	80.3±4.7	60	79.9±4.8
Boll bracts	102	91.1±2.4	153	88.7±2.6	120	80.9±4.6	180	80.8±4.7
Soil surface:								
In row	34	91.4±4.4	17	85.1±3.6	40	83.2±3.7	20	82.2±3.5
Bed shoulder	51	95.2±8.9	34	91.0±7.0	60	83.0±3.9	40	80.7±4.2
Row bottom	17	99.5±10.7	17	89.9±6.3	20	82.1±3.5	20	79.2±2.7
Midbed	17	93.4±4.1			20	83.2±3.1		
Aug. 3, 1971								
Air	21	88.0±2.1						
Plant:								
Terminal	21	90.4±3.7		(1/)				
Canopy	105	87.6±3.7	105	86.2±3.3				
Boll bracts	84	85.7±2.9	105	84.3±3.0				
Soil surface:								
In row	42	84.4±2.1	21	80.8±1.1				
Bed shoulder	42	86.5±4.6	42	87.5±7.7				
Row bottom	21	90.3±8.8	21	87.2±6.1				
Midbed	21	85.0±4.4						

1/ No data.

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